

X. *On the Courtship of certain European Acridiidae.*
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 F.L.S., etc.

[Read April 1st, 1896.]

THE extraordinarily fine and hot weather in Switzerland at the end of August and beginning of September last year (1895), was very favourable for the observations which are here recorded. I was then staying at the Weisshorn Hotel, high above Vissoye, in the Val d'Anniviers, 7690 feet in elevation. Certain species of *Acridiidae* were excessively abundant in the immediate neighbourhood of the hotel, species moreover which afforded examples of very different methods of courtship.

In working at this subject I received the greatest assistance from my two friends, Mr. F. Jenkinson and Mr. F. V. Dickins: their keen powers of observation enabled me to add many new facts of much interest, and also afforded valuable confirmation upon the most difficult points. Mr. Jenkinson observed with me for hours together on several occasions, so that we were able to compare our impressions as we received them.

Dr. Sharp has kindly identified the species for me, comparing my specimens with a Brunner collection at Cambridge.

The object of this enquiry was to make out the methods employed by the males in the courtship of the females, and especially the part played by stridulation. Dr. Sharp, in the Cambridge Natural History (Vol. v., p. 286), insists on the insufficiency of observations on this point, and I therefore hope that this work has not been in vain. The following observations suggest that the true significance of the latter is to be found in its use during courtship. In only a single species of those observed, *Stethophyma fuscum*, did the males commonly stridulate without reference to the females, and merely in rivalry with each other. In all the other sound-producing species the power seemed, almost without exception, to be

exercised with direct reference to females, or in rivalry to other males in the presence of a female. In the case of *Psophus stridulus*, true stridulation was only observed when the close proximity of a female had evidently thrown the male into a state of excitement.

The following considerations also support the same conclusions. In *Pezotettix pedestris*, both sexes have rudimentary wings and the male never makes any audible sound. Nevertheless, when he is seated on the back of the female attempting to pair, and during coitus itself, he continually moves his third legs alternately as if in stridulation. I believe that this movement is a vestige of an ancient and long-lost power of producing sound. Although stridulation is usually produced by a symmetrical movement of the third legs, it will be shown that this is not the case with *Stenobothrus elegans*. There is therefore no objection to be raised against this character of the movement in *Pezotettix*. Another view, and that held by my friend, the learned Orthopterist, Henri de Saussure, is that sound is really produced, only we cannot hear it. He holds that the sound is merely the outward expression of the elated feelings of the male *Pezotettix*.

Dr. Sharp, too, considers from the presence in apparently dumb species of well-developed tympana—and this is their condition in *Pezotettix*—"that the Orthoptera provided with acoustic organs, and which we consider dumb, are not really so, but produce sounds we cannot hear, and do so in some manner unknown to us" (Cambridge Natural History, Vol. v., 287). On the other hand, it may be urged that the perception of vibration by means of tympana may be of great value in the life of an organism, even if the organism were incapable of producing sounds, and that it may be retained for some more general use when its original special function has ceased to exist.

But in any case this movement of *Pezotettix* is conducted with an apparatus homologous with that by which sound is produced in other *Acridiidæ*, and yet one in which the special sound-producing structures are absent. The tegmina are too short to be brought into their usual relation with the femora, and the ridge on the inner face of the latter is without the "musical beads," although strongly chitinized and prominent as though it had previously possessed significance in this respect.

Further evidence in support of this explanation is to be found in the fact that *Pezotettix* makes the movement when he has succeeded in capturing the female and when pairing has actually begun. In the other species observed the normal arrangement was for the male to stridulate apparently to charm or please the female *before* leaping on her; stridulation after this occurring only in certain special cases (one observation on *Stenobothrus hæmorrhoidalis*, and one on *Stethophyma fuscum*, in which it is to be explained as an answer to another very persistent male).

If, however, as I suppose, the movements of *Pezotettix* are merely vestigial, we can quite understand their association in the nervous system with those stronger nervous impulses which are concerned with the successful issue of courtship, rather than with the impulses concerned with courtship itself. According to this view the functional stridulation is associated with anticipation while the vestigial stridulation is only evoked by realization. It should be added that it is quite possible that these movements of the male *Pezotettix* may have a stimulating or perhaps merely a soothing effect on the female.

The comparison between *Pezotettix* and the other species supports in another way these conclusions as to the essential significance of stridulation in courtship. In the latter kinds, so far as they were sufficiently observed, the female was treated with considerable ceremony; in *Gomphocerus* a peculiar attitude was assumed, movement of some of the appendages of the head was made, and the female was in some cases patted or stroked, in addition to the most assiduous stridulation. The latter was never omitted in any species in which we could detect any sound. But the little male of *Pezotettix*, being apparently without any power of charming the female, behaves in a manner entirely different from any of the others described below. He lies in wait, leaps on the female, and captures her unawares. Then, when he is firmly seated, the male attempts to charm her by nibbling with his mandibles, and perhaps by the effect of the alternate movement of his third legs.

The general impression left by the whole of the observations recorded below was favourable to the theory of sexual selection, and to the view that the stridulating

apparatus has been evolved by the agency of this principle rather than by that of natural selection.

Others may draw opposite conclusions from the same observations, which I therefore set forth by themselves, apart from general theoretical considerations. I believe that the observations themselves are correct, and that the uncertain points are stated with due caution.

PEZOTETTIX PEDESTRIS.

AUGUST 29, 1895.—I watched a pair of *Pezotettix pedestris* continuously for about an hour and a quarter, viz, from about 2.30 p.m. to 3.45. The day was fine and the sun powerful, and this had been the case for many days previous to the 29th.

When first observed, the male was seated on the back of the female, the anterior legs being clasped round her prothorax, but every now and then one of them was passed round her head and sometimes even over the eye. Twice the female was seen to raise her leg and sweep the male's leg off her face. The male's second pair of legs apparently clasped the posterior part of her first abdominal segment, fitting in between the femora of the female's third pair of legs and her body. The male's third pair of legs were not used for maintaining his position, but were held either horizontally or inclining upwards posteriorly, the tibiæ forming an acute angle with the femora, and the tarsus being raised so as to form an acute angle with the tibiæ. For nearly the whole of the time of observation the male's third legs were jerked up and down alternately, the strokes not succeeding each other very rapidly. No audible sound was produced. No corresponding movement was seen on the part of the female.

In attempting to copulate, the male let himself down, sometimes on one side and sometimes on the other, sufficiently far to bring the extremity of the abdomen below that of the female. The terminal segments of the male's abdomen were then turned upwards and inwards towards the external generative aperture of the female, with which the everted male organs were brought into contact. No movement of the corresponding female parts was seen, but contractions of the whole abdomen occasionally took

place. In the above-described attitude the hold of the male appeared to be very precarious, and it seemed that he would have been shaken off by a comparatively slight movement on the part of the female.

During the second half of the period of observation, the male made more frequent and vigorous attempts, and I noticed that from time to time he gently nibbled the female with his mandibles in the dorsal and upper part of the lateral thoracic regions. The female, however, appeared to be entirely indifferent to his attentions; and sometimes when the male was making the most energetic attempts she would calmly begin to eat the leaf of a plant. On two occasions she finished, or nearly finished, a small leaf, and many times nibbled parts of leaves. Although she seemed to prefer the green leaves, she sometimes ate portions of brown ones. Five times the female ejected fæces; once I thought the male did so, but it may merely have been getting rid of some foreign particle which had accidentally adhered. In the case of the female there was no doubt.

Although the female did not attempt to get rid of the male, she showed her indifference to his presence not only in the manner already described, but by walking and hopping about, often at the most inconvenient times. By 3.45 copulation had not commenced, and I could wait no longer. Both insects were then captured for identification.

All the observations recorded above were made quite close to the insects. By keeping as still as possible, and moving very gently when it was necessary to follow them, it was easy to bring the eyes within six or eight inches of the insects without disturbing them at all.

AUGUST 30.—I saw many of the same species in copula beside the upper road, or rather path, leading from the Weisshorn Hotel to Zinal. The terminal segments of the male's abdomen are turned upwards, in the position indicated by the attempts already described. The alternate movements of the third legs continue from time to time during coitus: in one case (which may have been the beginning of copulation) a female was seen to stretch out the third legs from time to time, and make a rapid shivering movement. With the above exception, the female hopped and walked about freely during the pro-

cess, the male being apparently firmly seated on her back.

AUGUST 31.—A pair were found in copula in the Alpine garden close to the Weisshorn Hotel. The female was seen to eat freely, and once to void excreta, while the male was actively moving his third legs. This observation was confirmed by F. Jenkinson. These remarkable alternate movements of the male's third legs during coitus were also seen by F. Jenkinson and me in a very large number of cases at other times. In a single case observed by F. Jenkinson on August 31, the male's legs were at one time rapidly vibrated laterally, being moved simultaneously and not alternately, as in the usual movement. This perhaps corresponds to the shivering movement seen by me in the female on August 30th.

SEPTEMBER 1.—This latter observation was confirmed by me in the Alpine garden. In this case the beginning of the act was seen. The male appeared to be much excited, and the shivering movement occurred from time to time, just before and after the beginning of the act. The female, which possessed only one leg of the third pair, was quite motionless throughout. At the commencement of the act she expelled fæces, which were moist and quite different from the dry ejecta seen on other occasions. In this and the complete passivity of the female there is probable evidence that she was much influenced by the act. This passive appearance was entirely distinct from the indifference manifested in so many of the cases previously observed, in which, however, the act had either not begun, or was probably far advanced. Shortly after coitus the pair remained motionless for a considerable time.

SEPTEMBER 2.—Up to this date the events immediately preceding pairing, and the pairing itself had been observed with care, but there was no evidence to show how the male became seated on the back of the female. I was very anxious to find out how this occurred, and whether there was any preliminary courtship by stridulation or otherwise, although the species had never been heard to stridulate. At this date, F. Jenkinson observed, and I was able to confirm, that the males leap upon the females when they come within a distance of about three inches, but apparently do not notice them at a much greater distance. Their attention appears to be directed to the

female by its movement, and they then leap with the greatest accuracy. F. Jenkinson obtained these results by inducing captured females to leap from his hand in the direction of a male. On one occasion he saw a male approach and leap upon another male, probably mistaking it for a female; there was a tussle, in which one appeared to try to bite the other. It thus appeared evident that there is no preliminary courtship of any kind, but that the male takes the female by surprise, and leaps upon her before she is aware of his presence. This conclusion was abundantly confirmed later on.

SEPTEMBER 3.—F. Jenkinson and I observed a pair on the grassy slopes below the Bella Tola. The male had lost one of the legs of the third pair, and the female had one of them apparently injured. The male was seated on the back of the female, and was energetically attempting to copulate much too far forward in the middle ventral line. We watched his continual attempts for about fifteen minutes, at the end of which period he was no nearer to success than at the beginning. This failure, when the female was evidently ready, and kept opening the generative orifice, may have been due to the absence of the leg. Although this limb is not used to hold firmly, the absence of it may have affected his balance. At any rate no failure of this kind was seen on any other occasion.

Later on, about the middle of the day, we came to a flat piece of ground covered with scanty grass, at the bottom of the zigzags by which the Bella Tola is ascended. The strong sun and the position of the ground made the place extremely hot, and as both sexes of the *Pezotettix* were very abundant, it appeared a good opportunity for observing the pairing habits. The males were often seated on stones, or other slight eminences; thus placed, and with the head and anterior part of the body raised, they were in a very favourable position to see and leap upon any female which approached within three inches, or sometimes even a greater distance. If the leap is a failure, the male at once begins an active pursuit, leaping more quickly and further than the female. In this way it often happens that he loses sight of the latter, or, is brought nearer to another female, whom he at once attempts to capture. One main cause of failure in the pursuit is that the male has very little, if any, power of

seeing a female between his leaps, unless his attention has been directed to her by the movement of the leap itself. Hence the pauses, often greatly prolonged, between the successive leaps frequently lead to the escape of the female. Furthermore, the leaps made by the male, when lying in wait for the female, were much better aimed than those made in pursuit. It is probable that in the former case he takes very careful aim; for he turns his head and antennæ in the exact direction of the female, and pauses before leaping, often making a slight rocking movement of the anterior part of the body. Occasionally this movement was seen in the female also.

When the male leaps upon her unawares, as I have described, the female almost invariably tries to throw him off, and generally succeeds. If, however, she failed in the first attempt, in most cases she yielded forthwith, and, probably as a result of these favourable conditions as regards temperature, pairing was effected in a very short time, sometimes even in a few seconds.

In one instance a male leaped upon a female and was thrown off; the female was then driven round, so that in a few minutes she again came within the range of his leap. The second time he was successful, securing a firm hold, and beginning to nibble the female with his mandibles. All resistance ceased, and pairing took place in a few minutes.

Very occasionally the alternate strokes, but only once or twice repeated, of the male's third legs were seen when the opposite sexes were near together. I believe, too, that the same movement was made by the female, though still more rarely. One female, when near to a male, seemed to be excited, and raised her third legs, which quivered from time to time. Any such indications were very rare in the female. In nearly all cases she was taken by surprise, and only yielded when very firmly held.

The female must be influenced in some way by the male holding her and caressing her with his mandibles; for his position, when attempting to copulate, is very precarious, and he could be easily shaken off. It appeared, however, that the males did not begin to make any such attempts until the females had ceased to resist.

In one single instance the female did not yield, although very firmly held; but it is probable that she was immature, or injured, or in some way unfit for pair-

ing, as the male finally left her of his own accord. This observation was made by both of us, and was of great interest. When we first saw them, the male was firmly holding the female, but she kept struggling violently, and trying to kick him off with her powerful third legs. On at least three separate occasions the pair rolled over, and remained in this position, with the male beneath, for about half a minute. At such times the female was unable to struggle at all successfully, and it seemed possible that the male, when he was nearly unseated, caused the pair to roll over; we could not, however, be sure of this. Ultimately the male leaped off voluntarily, as I have already stated. One side of the dorsal surface of an abdominal segment was wounded in the female, but as the injury did not appear to be fresh, it is not probable that the male caused it.

In one or two cases the female, and once the male, expelled faeces just before or during copulation. The faeces were of the character already described, and not in the usual dry state.

In no single case was any preliminary courtship witnessed in this species. There was no stridulation, no display of colour or attitude. It was entirely a question of capture, the females being almost invariably, at any rate at first, unwilling prisoners, although occasionally they showed indications of excitement in the presence of a male.

It is highly probable that pairing takes place many times in this species, and even more than once with the same male.

There was an extremely high proportion of individuals in coitu, even allowing for the fact that their habit of freely jumping about renders them much more conspicuous than the unpaired males and females. The proportion was far higher than that of any other Orthopterous insect observed during this visit to Switzerland; it is possible, however, that the principal pairing time of other species is earlier in the year.

GOMPHOCERUS SIBERICUS (var.).

This form was excessively abundant round the Weisshorn Hotel, no other species approaching it in numbers. On one occasion, after heavy rain, F. Jenkinson saw immense

numbers of them lying in the path apparently dead; but after the sun had warmed them they all recovered.

AUGUST 30.—At this date I had a good opportunity of watching the habits of the males in the presence of a female. About a mile from the hotel, along the upper road to Zinal, at about 11 a.m., I came upon a spot which, on account of its aspect and slope, had not long been warmed by the sun, so that the insects were only just beginning to bestir themselves. Here was a little group of this species—two males and a female—probably close to the place in which they had passed the night. The female was resting quietly on a small piece of rock, slightly moving her abdomen, probably in relation to respiration. Later on she drew each antenna beneath the first leg of the same side, or perhaps drew the leg over the antenna. It is probable that this movement is intended to wipe off the dew. The males often did the same, and the female rubbed its eye, probably for the same purpose. This explanation is all the more probable because I did not see these movements at any time when the heat of the sun was sufficient to have dispersed the dew; although the species was carefully observed on many occasions. One male, standing by the female, was stridulating when I came up; the other was behind motionless. These three insects were extremely shy, although this was by no means the case at other times when individuals of this species were watched in the heat of the day. Although I approached so that my shadow was behind me, and very gently, the male beside the female was alarmed at each slight rustle or movement, raising himself on his legs and erecting his antennæ, apparently thoroughly on the alert. Then when I kept perfectly still he resumed his former position and depressed the antennæ towards the female, both of whose antennæ were also generally depressed. He did not continue to stridulate, but, after remaining almost motionless for some ten minutes, except for cleaning his antennæ now and then, turned his back on the female and apparently began eating the heather. In a few seconds the other male stridulated once or twice: the effect on the first male was instantaneous; he stridulated for a second or two and then walked back to the female, depressed one antennæ towards her and patted her on the thorax with one of the first pair of legs. After all this

attention she made no apparent movement, and the other male did not make any further advances. The active male then walked away and met another female, stridulated beside her until she also walked off. Another male close at hand stridulated, and the active one immediately replied, although in this case no female was near.

These observations illustrate the habits of the species in courtship, the males, as Mr. F. V. Dickins also pointed out to me, always running after the females and never jumping, although both sexes jump very actively when disturbed. The use of stridulation as one of the tactics of courtship was clearly seen, the rivalry between the two males near the female being particularly interesting. The same occasion gave rise to the other method of courtship, viz., patting the female. The position of the male's antennæ suggested attention to any movement the female might make, or to anything she might do.

These notes also illustrate the immense abundance of the species, the active male had only to walk two or three inches away from the group of three in order to come across another female and male.

I think that, in observations of this kind, it will be useful to watch the species under many different conditions, especially as regards temperature. In the hottest places courtship is most energetic, and we have the most favourable opportunity for seeing the whole process carried through to completion, as in the case of *Pezotettix* already described; but when the temperature is lower, and especially when the warmth of the sun has only just roused the insects into activity, many interesting details may be witnessed which are often passed over or hurried through in times of greater energy.

In spite of the excessive abundance of the species and the almost constant attention of the males to the females, a successful termination to courtship was witnessed in no single instance, and only two or three pairs were seen in coitu. One of these was found on August 29th, a little below the hotel. The male, unlike the *Pezotettix*, was unable to retain his hold, and when the female jumped, as she did freely, he was dragged along on his back, and retained this position for a considerable time in the intervals between two successive jumps. It is probable that with this species, the pairing season was nearly over;

and this conclusion is supported by the fact that the females were often seen engaged in oviposition.

AUGUST 31.—Jenkinson and I watched several females ovipositing in the loose earth on a very hot slope just outside the hotel, and in the beds of the little Alpine garden. The female thrusts her abdomen deeply into the earth and remains in this position for some minutes. On two occasions a female, after withdrawing her abdomen, was seen to rake the ground vigorously with her third legs, and, in one case, witnessed by Jenkinson, she steadied herself by holding a plant stem with her mandibles. We several times dug up the earth and searched for the eggs, but without success. At this date I found another pair of this species in coitu, on the path just below the hotel.

Gomphoceris sibericus appears to be a very general feeder, and its extraordinary abundance in the immediate proximity of the hotel was probably due to the presence of horses' and mules' dung, and other refuse upon which they fed. Every patch of dung upon the path was surrounded by dozens of individuals.

AUGUST 31.—F. Jenkinson and I watched the males pursuing the females near the hotel. It often happened that when a male came up to a female he extended the maxillary and labial palpi towards her, and raised himself on his legs in a very characteristic and remarkable attitude. At other times these movements occurred at a later stage of courtship. The movement of the palpi strongly suggested their use as organs of sense. When the female ran away, as she generally did, the male pursued, always trying to get in front of the female and thus stop her. The male ran faster than the female, and altered his direction so as to approach the female almost at right angles to the course she was pursuing. After the preliminaries of courtship—pursuit, stridulation, attitude, and movement of the palpi—the male, standing beside and close to the female, tries to jump on her, making a curious short chirp as he does so. The attempts were, however, always unsuccessful in the cases observed by us. Stridulation is in this species of definite length, and ends in two or three short chirps; in most cases the male then instantly approaches still nearer and tries to jump on the female with the short chirp already described.

Neither Jenkinson nor I can remember the exact

order in which the male went through the various phases of courtship. It is probable that the order varied greatly, and that some of the phases were often omitted.

SEPTEMBER 2.—On this and many other occasions the males were often seen to leave the female they were pursuing and, apparently without knowing it, to follow some other female they accidentally came upon in the course of the pursuit. A male pursuing a female was once seen to approach and jump at the male of *Pezotettix*, having apparently mistaken it for the female.

SEPTEMBER 3.—On the grassy slopes below the Bella Tola, a male observed by F. Jenkinson and me was greatly excited by the pair of *Pezotettix* already described as attempting, but unable to copulate. He stood in the characteristic attitude, walked round them, and finally stood in front and stridulated for the usual length of time and with the usual ending, he then advanced as if to jump, but before doing so became satisfied that he had made a mistake, and walked away. It was evident that he had mistaken the pair for the female of his own species.

Just below the zigzags up the Bella Tola we saw a male which, standing by a female, repeated the stridulation four times with the usual conclusion on each occasion, and then after all this attention let her walk away unperceived. This and the other facts already described seem to show that the males were very unobservant. In this respect their behaviour was very different from that of *Pezotettix*, and from the very alert member of their own species observed on August 30.

No light was thrown upon the function of the remarkable dilated tibiæ of the first legs of the male. The whole tibia, swollen into the shape of a pear, with the tarsus articulated to its broader end, presented a most curious appearance in the characteristic attitudes assumed during courtship. On the underside of this dilated mass, which is approximately circular in transverse section, two rows of hairs are seen. Although the hairs are smaller, and the rows more widely separated, both evidently correspond to those which are found beneath the unmodified tibiæ of the other legs.

Although we observed the habits of this species on many other occasions, neither F. Jenkinson nor I had ever seen the pairing accomplished. I therefore asked Mr. F. V. Dickins if he would consent to watch through

a very hot afternoon. This he very kindly did, and although unsuccessful in this respect, he made many interesting observations which I give in his own words:—

“On the 4th September, 1895, I watched the courting habits of some grasshoppers on the knoll immediately behind the Weisshorn Hotel.

“At first I made my observations on the west slope, but there was a cool wind blowing, and the insects were neither numerous nor lively. Casting about I discovered on the south-east slope a particular hollow away from the wind, in the full glare of the sun, and focussing the heat-reflections from the hillock-slopes around it. Here the grasshoppers abounded and were very lively; I watched them for about two hours.

“I noticed that the males, marked by swellings on their first legs, were much more mobile than the females, the latter were mostly extremely passive and had to be chased and caught up by the males. There was a good deal of this chasing which was very amusing to watch. Sometimes the female, as if bothered, would remain quiet for a time and allow the male to come up to her. He appeared to stroke her with his antennæ, but I could not distinctly see what parts of her body he thus specially caressed. The insects never seemed to leap unless alarmed; I thought that perhaps leaping was not an ordinary mode of progression. I saw no male clasp or leap upon any female; they chased and chased, threw up the game, started a fresh pursuit, equally bootless, and so went on, tireless. I was not fortunate enough to see any *accouplement*. When the male was alongside the female, in many cases, the insect assumed a strained attitude, the anterior part of the body being raised high, and the terminal segments curved upwards so that the dorsal line was concave antero-posteriorly. Very often a curious little click was heard, I thought, usually as the chase ended in the pair suddenly standing still by each other. One might suppose that it was a chirp of triumph. I have no doubt it was made by the male.

“One rather curious situation in this active little drama is worth noting. A female alighted or rather ran up on my boot and sat quite still in the hot rays of the sun. She sat so still that the idea struck me I might try to caress her a little myself. I accordingly looked round for a slender flexible grass stem or dried haulm,

and having found one gently touched her with the pliant extremity. She did not stir, and I became bolder; I rubbed her body on either side and also the inside of the coxæ and antennæ. She was still unmoved, except that a slight rigidity seemed to supervene, and the abdominal extremity curved slightly upwards. Gently tickling this part the curve rose and the rigidity seemed more marked. I now stroked her as gently as I could, and she permitted this extreme familiarity without resentment. Lastly, I took her softly up and laid her in the palm of my hand. Turning her from side to side she seemed quite content and did not exhibit a flutter or a tremor. I continued my caressings for ten minutes or a quarter of an hour, and then laid her in a warm spot and watched her for another quarter of an hour. She did not move, although she was alive enough. Was she hypnotized?"

This last interesting observation suggests that very marked effects may be produced by the patting which I witnessed on August 30th, and by the nibbling in the case of *Pezotettix*. In this latter species, indeed, the effect produced on a female after her first unsuccessful attempts to throw off the male, appeared to be very much like that induced by Mr. Dickins in the female of *Gomphocerus*.

STETHOPHYMA FUSCUM.

This magnificent species was very abundant in the open grassy spaces between the trees at the water-courses some few hundred feet below the hotel, and also in certain places on the slopes far below the Bella Tola. The stridulation was far more characteristic than that of any other species observed: first three (sometimes two) strokes of the third legs across the tegmina, then a rapid vibration of the former against the latter for a few seconds. The result is three piercing sounds in rapid succession, and then a prolonged rustle. The rivalry between the males and their replies one to another were very evident, but their relations to the female were only witnessed once or twice.

AUGUST 31.—This species was observed by the water-courses. Many females were seen but never attended by males on this occasion. I came across a pair of males in the grass fighting in a very clumsy manner: they lay

side by side, pushing and kicking at each other, and stridulating alternately. One male had lost one of the third pair of legs, perhaps in an earlier part of the fight, but if so it must have been somewhere else, as I searched for the leg in vain. In spite of its mutilation it replied with its single leg to every stridulation made by the other, and these replies seemed especially irritating to the uninjured male for it kicked more vigorously than ever, and once made a determined but unsuccessful effort to bite the end of the other's abdomen. The fight was already raging when I began to observe. After I had watched it for several minutes the uninjured male gave up and went away. It is possible that the fight may have begun by one male leaping on the other in mistake for a female, but it is more likely that it arose in a quarrel over one female. This view derives some support from the following observation.

SEPTEMBER 2.—At a certain spot on the slopes below the Bella Tola the species was very common, and several pairs were seen in coitu. The female is larger and duller in colour than the males, and her wings are much smaller and probably useless for flight.

In the case of one pair in which copulation had evidently only just taken place, the female was seen to expel faeces: another male was lying beside the pair evidently trying to copulate with the female, continually stretching his abdomen towards her with partial eversion of the organs. He also stridulated from time to time, and I feel almost sure, although I cannot speak with certainty on this point, that the copulating male replied on each occasion. In a few minutes the unsuccessful male went away. I have suggested that the fight may have begun in some such contest, but probably before either male had succeeded in pairing. I cannot now remember whether the stridulation during the fight and on the occasion last described was similar to that which is characteristic of the species at other times. I am confident that no new sound was introduced, but cannot be sure as to whether both movements were made with their usual relation to each other.

SEPTEMBER 7.—F. Jenkinson saw two males of this species drawn together from a distance of several yards apparently as the result of stridulating alternately. When at length they met, they seemed much excited,

but soon separated without fighting. Perhaps the fight which I witnessed may have begun in this way.

STENOBOTHRUS (?) ELEGANS.

A beautiful little species which Dr. Sharp doubtfully identifies as *Stenobothrus elegans*, was often seen, although not abundant, below the hotel. The males in stridulating, do not, like the two last mentioned species, move the third legs symmetrically, but one follows the other. Probably in consequence of this the sound swells and diminishes rhythmically, presenting a remarkable likeness to that made by a fly caught in a spider's web. Considering its very small volume, this high and piercing sound can be heard for a great distance.

STENOBOTHRUS HÆMORRHOIDALIS.

After I left, F. Jenkinson observed a very small kind which is almost certainly to be identified as the above named species. Mr. Jenkinson has kindly given me the following notes:—

“SEPTEMBER 5.—About 5 p.m. I found a very small brown male, with the dorsal surface of the abdomen of a reddish-orange colour. He was very assiduous in his attentions to a green female with white V-shaped marks on the side of the thorax. He generally kept close to her, but was never obtrusive in his attentions, relying apparently on the effect of his stridulation. This was made with both legs simultaneously, generally very low, but sometimes louder, a rapid uniform trill, rather like the note of the lesser whitethroat. Sometimes she gave him the slip, and they were as much as eight inches apart, and out of sight of each other; but he continued at short intervals his stridulation, and somehow, *apparently* by accident, they came across each other again, and the male posted himself in close attendance as before. The female was generally nibbling at blades of grass. If the male touched her, she seemed to repel him by raising one of the third pair of legs. At 6.45 the sun was setting, and I had to go, so I boxed them both. The male was perhaps just beginning to relax his energy.

“SEPTEMBER 7.—Below Weisshorn Hotel. A male was stridulating and following a female, and was more

successful in finding her again than any other species I have observed. At 5·30 the male jumped on the posterior part of the female's body, his legs round her tegmina. In this position he continued to stridulate although at rare intervals (he did so at 5·50). The female carrying the male shifted backwards moving her abdomen. She seemed to have some difficulty in expelling faeces, and this was apparently the cause of the movement. The male stridulated, and then at 6·0, without having copulated, he quitted the female, stridulated, and went away."

PSOPHUS STRIDULUS.

The large black males were common just below the hotel, and on some slopes below the Bella Tola, where *Stethophyma fuscum* abounded. Their red under wings were very conspicuous when flying, the characteristic rattling sound still further attracting attention to them. The larger brown, toad-like females, with smaller wings, are probably unable to fly.

I never saw the sexes together; but after I had left, F. Jenkinson kindly sent me the following notes:—

"SEPTEMBER 5.—When the male finds himself near a female, he utters a double 'twitter' (once a twitter and then a trill), and moves excitedly. In one case I saw him leap on the back of a female, but presently he left her of his own accord.

"At 3 p.m. I came across a pair in coitu, but the male disengaged himself by vigorous movements of the third legs. They remained for a long time within two inches of each other, but nothing happened. I made the female jump away, caught her, and put her in the male's way. He at once became excited, and twittered, but the female escaped. This occurred more than once, when I lost her.

"A male, disturbed as I came home (about 6·45 p.m., when the sun was setting), hopped vigorously, but did not open his wings." This latter observation is of interest, because the males always took to flight, when disturbed, on other occasions.

"SEPTEMBER 7.—On placing the female near the male, he became excited, and made a twittering sound with his legs. The female, in moving off, showed the red

under wings, but even in the open path, the male seemed to lose her at once. In another case, when the female came near, the male jumped right away."

It is noteworthy that most of the observations upon the last-named two species were made late in the afternoon, when the sun was losing its power.

CE DIPODA CÆRULESCENS.

I had long wished to study the courtship of these beautiful insects, but there were none round the Weisshorn Hotel. Lower, at San Luc (5390 feet), they began to appear, and still lower, at Vissoye (4006 feet), and all along the main valley road, they were excessively abundant. They are always difficult to observe, because they haunt places where the combination of direct heat with that reflected from rocks or bare slopes, is almost unbearable. I had no time to observe them until we had come down to Fribourg.

SEPTEMBER 9.—These insects were very abundant in a large gravel pit, just outside the gate of the town, on the road to La Roche. There is little doubt that they belonged to the above-named species. They were very lively, continually flitting about over the bare earth and gravel. They are very shy, and it is necessary to keep perfectly still in the intolerable heat, in order to watch their habits. I noticed that the males move their third legs as if in stridulation, but that no audible sound was emitted. There is an apparent lack of intention and effort about their movement which suggested that the habit is probably only a vestige, and possesses no other significance. The legs were raised, and seemed to be allowed to drop by their own weight. Furthermore, these strokes were not repeated at regular intervals, but quite irregularly, and often singly. In this case I did not secure any material, and therefore cannot speak with any confidence; but I anticipate that the legs will be found to be without the sound-producing structures.

A female remained motionless on the ground near to me. She was much larger than the males, and the exposed surface of her body and wings was of a redder brown. The males were extremely acute in detecting her presence, although she made no movement, and looked exactly like a part of the ground. Whenever a

male perceived her, he instantly approached without any preliminary courtship, leaped upon her back, remained a few seconds, and then voluntarily left her. The female did not make any apparent movement, although I saw quite half-a-dozen males leap upon her in the course of a few minutes. The males never met near her, and I saw no signs of any fighting. I could not tell whether there was any actual pairing, but it is improbable that this could have occurred in so short a time. It is likely that the males found that she was in some way unfit for pairing, and then left her. I have already implied that there was no special display of the beautiful blue under wings for the benefit of the female.

I trust that I may be able to make further observations upon these beautiful and interesting insects at some later date.